Some improvements on the static analysis a large pneumatic envelope

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Abstract

This paper presents some results on a current investigation on the influence of shape variation on the structural response of the large, cable-reinforced pneumatic envelope shown in Figure 1. The system has been previously studied with respect to membrane wrinkling and adherent or sliding conditions between cables and membrane, as reported in [1]. It was shown that these factors are significant to the determination of the system's deformation and overall stress and load distributions. However, due to restrictions of the analysis code, the study considered constant internal pressure and wind loads, which were evaluated according to static wind pressure coefficients adapted from the literature.

Current development of SATS program now allows updating internal pressure and the system stiffness according to the deformation of the membrane envelope, Thus, the present paper will resume the former analyses, to assess the influence of the deformation of the pressure envelope on the system's static response under wind loads. Some preliminary analyses show that the variation of the envelope volume does stiffen the system, at the expense of somewhat larger boundary loads.

The paper will compare the performance of different methods to solve the resulting nonlinear equilibrium problem. In particular, it will investigate the performance of assembling the system's tangent stiffness matrix through a straightforward finite-difference scheme, already used in [1], compared with the addition of a 'volumetric stiffness' to the system's analytical tangent stiffness.

An investigation on the influence of the envelope deformations on the wind pressure coefficients is currently on the way, coupling SATS with Fluent program, and results will be presented in the full paper and during IASS 2019 Symposium.

Figure 1: (a) A large pneumatic dome reinforced by sliding cables; (b) finite element mesh and equilibrium geometry under internal pressure.

References

[1]   Pauletti, R.M.O. and Gellin, "The influence of cable sliding on the structural response of a large pneumatic envelope". Proceedings of the International Association for Shell and Spatial Structures (IASS) Symposium 2015 - Future Visions. 17 - 20 August 2015, Amsterdam, The Netherlands.